

**DISTRIBUTION OF *SPEYERIA DIANA*  
(LEPIDOPTERA: NYMPHALIDAE)  
IN THE HIGHLANDS OF  
ARKANSAS, MISSOURI AND OKLAHOMA,  
WITH COMMENTS ON CONSERVATION<sup>1</sup>**

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**ABSTRACT:** Information from recent field observations, museum specimens, collectors' lists and published records is provided to update knowledge on the distribution and habitat associations of the Diana fritillary in the Interior Highlands of Arkansas, Missouri, and Oklahoma. *Speyeria diana* has been observed at 11 localities since 1980 and nine localities prior to 1980, the earliest of which is a Missouri state record from 1819. Two records are known from Missouri and two from Oklahoma since 1980, the remaining recent records are from Arkansas. Extant populations of the Diana fritillary in the Interior Highlands are few in number and most appear to consist of small numbers of individuals. These populations appear to be isolated from those in the southern Appalachians due to the species' extirpation from the middle portion of its historical range. Conservation efforts should focus on identifying and preserving habitats occupied by females, since they occupy a more limited range of habitats than males.

Several North American species of the fritillary butterfly genus *Speyeria* have become a source of concern for conservation biologists. Distributions have become increasingly fragmented and reduced, presumably due to human disturbances to the butterflies' optimal habitats, and those of the larval foodplants, violets (Violaceae: *Viola* spp.) (Hammond, 1995; Hammond and McCorkle, 1983). Several authors have documented or suggested that the Diana, or Great Smokies fritillary, *Speyeria diana* (Cramer), has undergone such a range reduction. Clark (1951) noted its decline in Virginia. Shull (1987) reported that it had not been collected in Indiana since 1962 and Howe (1975) suggested that it might be extinct in Missouri. The species is a candidate for listing as a protected, threatened or endangered species (PETS) under the Endangered Species Act of the United States (Federal Register, 1991, Vol. 56, no. 225, p. 58,831).

The Diana fritillary is a forest species, the larvae of which feed on a variety of forest-dwelling *Viola* spp. (Opler and Krizek, 1984; Scott, 1986; Allen, in press). Published records indicate a historical range throughout the southern Appalachian Mountains from West Virginia to northern Georgia and eastern Tennessee and Kentucky, scattered localities in southern Ohio, Indiana, Illinois

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and Mississippi, and the Interior Highlands of Arkansas and Missouri (Fig. 1) (Allen, in press; Holland, 1931; Hovanitz, 1963; Mather and Mather, 1958; Opler, 1992; Opler and Krizek, 1984; Scott, 1986). A sight record for Louisiana (Tallulah, Madison Parish) is mentioned by Mather and Mather (1958), but we do not consider it reliable enough to include Louisiana in the historical range.

Recent distributional data indicate a broad disjunction across the middle portion of the range, again suggesting that the species' distribution is becoming more restricted. In the eastern portion of its range, the Diana fritillary is widespread and individuals may be abundant at some localities in West Virginia (T. J. Allen, personal communication, Aug. 1995). The distribution of the species in the Ozark and Ouachita Interior Highlands (as defined by Thornbury, 1965) is more problematic. For a number of years, the only well-known population in Arkansas was in Logan County in west-central Arkansas. Several localities in Missouri and Oklahoma were known to local collectors. The overall impression has been that the Interior Highland populations were isolated, few in number, and comprised small numbers of individuals.

We conducted a survey for the Diana fritillary during 1992-1995. In this paper, we report field observations by ourselves and colleagues, data compiled from museum specimens, and published and unpublished records to update the known distribution and habitat associations of the Diana fritillary in the western portion of its range. We also discuss the status of the Diana fritillary in the Interior Highlands from a conservation perspective in light of these additional data.

## METHODS

This survey was conducted in conjunction with other research projects that required extensive travel throughout the Interior Highlands of Arkansas. The primary survey method was visual searching for patrolling males. No attempts were made to capture the butterflies, but they were observed until a positive species determination was made. Several specimens were captured in malaise traps set out for other purposes. These specimens were cleaned, mounted, and deposited in the University of Arkansas Arthropod Museum.

These observations were supplemented by interviews with individuals having knowledge of butterfly identification. Only reliable field observations are reported, and the identities and affiliations of the persons who made the observations are provided. Finally, data were collected from specimens housed in entomology museums in the region and from private collectors' lists.

Because these populations are small they may be at risk from overcollecting. Therefore, county records only are provided for recent records. More detailed locality data are available from the senior author to researchers.

The only sympatric butterfly species in the Interior Highlands that is likely to be confused with male Diana fritillaries is the great spangled fritillary (*S.*

*cybele* [F.]. Close observation is necessary to distinguish the two species. Male Diana fritillaries have abruptly bicolored brown and yellow-orange wings, and bear only small lunate silver spots on the undersides of the hind wings, whereas great spangled fritillaries have more gradually bicolored brown and orange-yellow wings and have large, conspicuous silver spots on the undersides of the hind wings.

## RESULTS AND DISCUSSION

**Published records.** MISSOURI: "Missouri" 1819; "Missouri" (Proc. Ent. Soc. Philadelphia 3: 432, 1864; Bull. Buffalo Soc. Entomol. 2: 259, 1895, not seen, information provided by Mike Skinner, Missouri Department of Conservation); **Greene Co.**, SE of Springfield, 22 August (Sell, 1916); **Taney Co.**, Hollister, August 1925, male and female (Kite, 1934). ARKANSAS: "Ozarks" (Scott, 1986); **Scott Co.**, Mill Creek, 10 June 1992, Gary Gier (McKown, 1993).

**Collectors' lists.** MISSOURI: **Jackson Co.**, Kansas City, Miner Park, 27 June 1986, 1 male, Gary Gier. OKLAHOMA: **Cherokee Co.**, Cherokee Landing on Lake Tenkiller, 8 August 1962, Pete Loy, John Nelson; **Leflore Co.**, 8 June 1992, Gary Gier; **Mayes Co.**, Jeff Frey, no additional data; **McCurtain Co.**, Bill Carter (collection record), Connie Taylor (photograph), no additional data; **Pittsburg Co.**, 5 July 1983, Robert J. Warren.

Additional records: John Masters in letter dated 9 March 1968: ARKANSAS: **Conway Co.**, Petit Jean Mtn.; **Faulkner Co.**, "various spots"; **Newton Co.**, Ponca, Lost Valley, "very common"; MISSOURI: **Iron Co.**, Tom Sauk Mtn. and Current River.

**Museum specimen data.** Acronyms: Louisiana State Arthropod Museum-LSAM; University of Arkansas Arthropod Museum-UAAM; Wilbur Enns Entomology Museum, University of Missouri-UMEM. ARKANSAS: **Logan Co.**, 23 June 1984, L. D. Newsome, 1 female (LSAM); 18 August 1984, upland hardwood forest, 1 male, 4 females, R. T. Allen (UAAM); 20 June 1985, hardwood/pine, developed campground, 2 males, R. T. Allen (UAAM); 10 July 1985, L. D. Newsome, 4 males (LSAM); June 1986, L. D. Newsome, 1 male (LSAM); 23-26 June 1988, T. J. Riley, D. LeDoux, 1 male (LSAM); **Montgomery Co.**, pine/hardwood forest adjacent to pine/hardwood shelterwood stand one year post-harvest, malaise trap, 1 July 1993, 1 male, C. E. Carlton (UAAM); **Perry Co.**, group selection stand one year post harvest, 17 June 1993, malaise trap, 1 male, C. E. Carlton (UAAM); **Washington Co.**, 22 August 1977, 1 female (UAAM). MISSOURI: **Jefferson Co.**, Pevely, 21 June 1896, 1 male, H. Hurter (UMEM).

**Field observations.** ARKANSAS: **Crawford Co.**, hardwood/pine edge habitat, 6 June 1995, 1 male, Lori Spencer Nobles; **Howard Co.**, second growth pine hardwood forest and even-aged pine stands of various ages, 7 June 1994, 5 males, C. E. Carlton; **Newton Co.**, public swimming/picnic area, upland hardwood forest, visiting : moist gravel, June 1994, males and females, Linda Bishop, (National Park Service, Harrison, AR); **Perry Co.**, group selection stand one year post-harvest, 17 June 1993, 1 male, C. E. Carlton; **Sebastian Co.**, tallgrass prairie/patchy forest and dense undergrowth, 16 June 1994, 1 male, C. E. Carlton. MISSOURI: **Barry Co.**, mature upland hardwood forest, August 1994, numerous males, K. S. Johnson (Department of Biological Sciences, Ohio University, Athens).

These records total 11 localities for the Diana fritillary since 1980, nine prior to 1980, and two undated, excluding the early state records (Fig. 2).

The predominant natural habitats at the Logan and Newton County, Arkansas localities are mature upland hardwood and pine/hardwood forests, although most specimens were in edge habitats within or near campgrounds and highway rights of ways. Habitats at the Montgomery and Perry County localities are

mixed pine-hardwood upland forests, slightly to moderately disturbed by recent timber harvesting but with relatively undisturbed mature forests nearby. In Howard County, where five males were observed during a one-hour period, the habitat was a mosaic of severely disturbed pine and second growth mixed forest in various stages of succession with a dense understory of woody vines, shrubs and small trees. The landscape in the area gave the impression of being degraded by years of even-aged timber management. The Sebastian County record is in an area of mixed agriculture and heavy industry. Scattered remnants of natural habitat included tallgrass prairie, patchy thickets of small oaks, elms and black locusts, and a few stands of mature hardwood and pine/hardwood forest.

The Barry County observation is the first report of the *Diana fritillary* in Missouri since the Kansas City record from 1986. Richard Heitzman (personal communication) stated that the Kansas City specimen was worn and probably a stray since there are no other records within 200 miles of the site. Confirmation of the Barry County record is necessary to establish with certainty that the species is extant in Missouri.

Nelson (1979), in his species list for Oklahoma, noted that the species "is found only in the eastern counties where the Ozark Plateau just extends into the state." In recent correspondence, Dr. Nelson indicated that he has seen specimens in 4-H collections at the Tulsa County Fair with some frequency.

Notably absent from the field observations are females. Clark (1951) noted that females prefer well wooded ravines and mountain sides, often in association with cold seepages and streams. Males patrol a wider range of habitats (Opler, 1992), a behavior which assists in field surveys, but contributes little to understanding the habitat limitations affecting the success of the species. The *Diana fritillary* is not restricted to large continuous areas of mature forest, but requires patches of moist, dense forest for female habitat, and to support the growth of violets and provide protection for overwintering first instar larvae (Clark, 1951; Allen, in press). Although Hovanitz (1963) argued that deforestation was not the primary cause for the decline of the species, the scale of deforestation in the middle portion of its range, from Illinois to Ohio, cannot be discounted as a contributing factor.

The *Diana fritillary* is widely distributed in the Interior Highlands based on available data (Fig. 2). However, extant populations appear to be isolated from each other, and comprise few individuals. If this characterization is accurate, these populations are at risk from unfavorable weather conditions, particularly the droughts that are characteristic of the region and from human disturbances to the habitats necessary for the females. Further, it appears likely that the Interior Highlands populations are geographically isolated from those in the southern Appalachians due to the extirpation of the species from the middle portion of its historical range across southern Illinois, Indiana, and Ohio. This could lead to reduced fitness due to loss of genetic variability as populations become

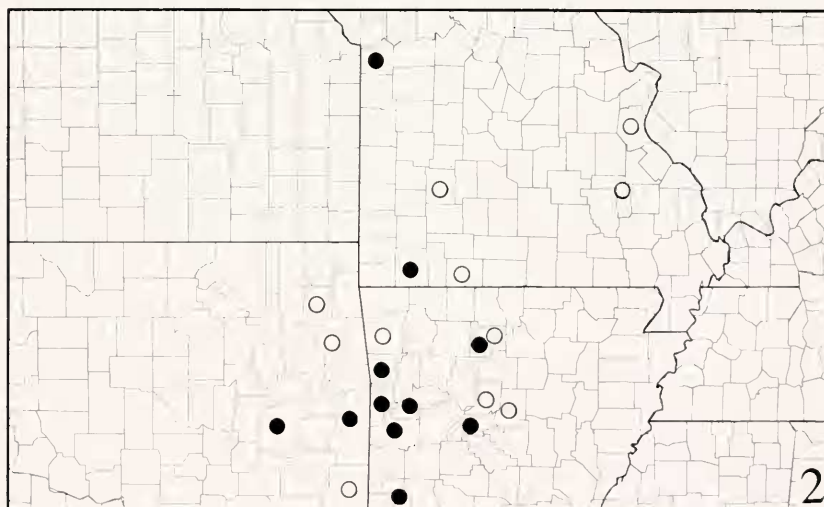
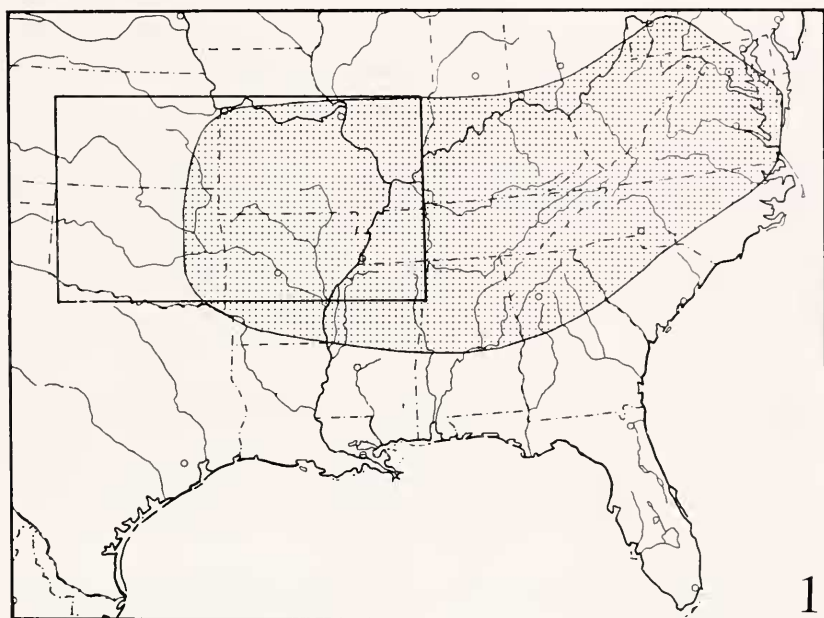


Fig. 1. Dotted area indicates the historical range of *Speyeria diana* based on references cited in text and current data. Inset indicates area covered by Fig. 2.  
Fig. 2. Locality records of *S. diana* in the Interior Highlands. Open circles = records prior to 1980. Solid circles = records 1980-1994.



more isolated from each other and from the larger pool of populations in the east.

The Diana fritillary has never been regarded as common in the Interior Highlands, so the data provided here neither support or refute a significant decline of the species' density in recent years, but clearly it remains uncommon. The species should be monitored in the Interior Highlands as an environmentally fragile species that is surviving in patchy habitats near the western limit of its range. Additional research is necessary to develop a better understanding of the conservation needs of the Diana fritillary in the Interior Highlands. Studies of larval food preferences and overwintering microhabitats would document differences in larval habits and causes of mortality between Interior Highlands and southern Appalachian populations. Investigations of potential competitive interactions with its more abundant congener, the great spangled fritillary (*S. cybele*) would clarify the role, if any, of interspecific competition in limiting the species' success. Molecular studies of Diana populations throughout its current range would contribute to our understanding of gene flow within the Interior Highlands populations and between them and southern Appalachian populations.

Perhaps the most practical approach to preserving individual populations of the Diana fritillary in the Interior Highlands and elsewhere for the near future would be to extend survey efforts to females and determine the sizes of the areas where females occur. Active measures could then be taken to preserve and monitor those areas and adjacent areas of similar habitat.

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## BOOK REVIEW

**INSECTS THROUGH THE SEASONS.** Gilbert Waldbauer. 1996. Harvard Univ. Press. 289 pp., Hd. \$24.95.

Not since Ross E. Hutchins in the 1960's has anyone written about insects in such a fascinating and engaging, yet scientifically accurate, manner as Waldbauer has in this outstanding volume. Truly, this is one of those rare books that, once started, is hard to put down until completed.

The author's stated purpose is to explore, from an ecological perspective, the reasons why insects are the most successful of all animal groups and to consider some of the evolutionary adaptations that have made it possible for them to be so successful. Waldbauer has achieved this purpose admirably. Starting from the basic premise that achievement of evolutionary fitness involves three imperatives: the insect must avoid being eaten; it must itself eat and grow; and it must successfully reproduce itself. Waldbauer proceeds to take a reader through segments of the life cycles of different insects from their emergences from winter diapause throughout the seasons of the year. Some of the chapter headings are: Finding and Courting a Mate; After the Courtship's Over; Caring for Offspring; Defense against Predators; The Parasitic Way of Life; Recognizing Food; Taking Nourishment; Coping with the Seasons; Silken Cocoons; and Winter.

Far from being staid chapter headings, together these read almost like a who-done-it novel as one constantly wants to know what ecological event is next to be related. For example, the great diversity of methods employed in the Caring for Offspring chapter and the adaptations for survival recounted in the chapter on Defense against Predators are both fascinating and the study of insect sex lives is well supported with the example of the eradication of the screwworm fly. Throughout this work, Waldbauer illustrates and supports his many points with abundant and diverse citations based on research.

One does not have to be an entomologist, professional or amateur, to appreciate this book. Its interesting writing style makes it easily readable by ecologists, naturalists and even laymen, though a basic knowledge of entomology would greatly enhance a reader's appreciation of this work. Every entomologist, no matter his or her discipline or how advanced in his or her knowledge in this field, will surely appreciate and enjoy this fascinating offering.

H.P.B.